



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL VEHICLE AND FUEL EMISSIONS LABORATORY
2565 PLYMOUTH ROAD
ANN ARBOR, MICHIGAN 48105-2498

OFFICE OF
AIR AND RADIATION

January 19, 2001

CCD-01-02 (HD)

Dear Manufacturer

Subject: Advisory Circular 24-3

Enclosed for your use is an Advisory Circular (A/C) 24-3, "Implementation of Requirements Prohibiting Defeat Devices for On-Highway Heavy-Duty Diesel Engines." We have prepared this A/C to assist manufacturers in better understanding how EPA will implement the Clean Air Act prohibition of defeat devices as they might occur in heavy-duty diesel engines certified for use in on-highway applications. In particular, this A/C focuses on how data generated under the Supplemental Emission Test and the Not-To-Exceed test will be used when evaluating the emission performance of diesel engines designed to meet the 2.4 g/bhp-hr HC+NOx emission standard prior to model year 2007 when acceptable emission performance over these tests are mandated by our regulations. This A/C references and incorporates a number of the provisions included in the October 15, 1998 guidance letter to manufacturers, "Subject: Heavy-duty Diesel Engines Controlled by Onboard Computers: Guidance on Reporting and Evaluating Auxiliary Emission Control Devices and the Defeat Device Prohibition of the Clean Air Act."

From the enclosed A/C 24-3, we have described how manufacturers can use data generated over these tests to provide themselves with greater assurance that their engines and emission control systems do not contain devices or design strategies that could be considered by EPA as possible defeat devices. Additionally, we encourage manufacturers to supply information to EPA during certification regarding performance over these cycles. Supplying such data will help speed EPA's review of the application and enable completing certification in the minimum amount of time.

If you have additional questions regarding this guidance, please do not hesitate to contact your EPA certification representative. If a widespread industry response suggests a general follow-up meeting would be useful, we will schedule this at the earliest opportunity to assure maximum time is available to manufacturers to reflect this guidance in their future certification programs.

Sincerely,

Gregory A. Green, Director
Certification and Compliance Division
Office of Transportation and Air Quality

Bruce C. Buckheit, Director
Air Enforcement Division
Office of Regulatory Enforcement

Enclosure



Printed on Recycled Paper

January 19, 2001

Advisory Circular Number 24-3: Implementation of Requirements Prohibiting Defeat Devices for On-Highway Heavy-Duty Engines

I. Purpose

The purpose of this advisory circular (A/C) is to provide manufacturers additional guidance regarding EPA's procedures for evaluating Auxiliary Emission Control Devices (AECDs) associated with on-highway heavy-duty diesel engines designed to meet the 2.4 g/bhp-hr NMHC + NO_x FTP emission standard. Specifically, this A/C extends 1998 Guidance Document VPCD-98-13 to those technologies expected to be used to meet the 2004 model year standards and provides objective screening criteria to assist both the manufacturer and EPA in evaluating AECDs. This A/C supplements and does not supersede A/C 24 and A/C 24-2 which remain in effect. This A/C also references and incorporates portions of the 1998 guidance document which also remains in effect and is the particular source for clarifying AECD reporting requirements.

II. Background

A. On December 11, 1972, EPA published A/C 24 which provided general implementation guidelines and policies regarding how EPA would enforce the prohibition on defeat devices.

B. On December 6, 1978, EPA published Advisory Circular 24-2, "Prohibition of Emission Control Defeat Devices - Optional Objective Criteria," which provided additional guidance from the Agency regarding the prohibition on the use of defeat devices, including the use of the Highway Fuel Economy Test as a supplemental test for evaluating the emission impact of AECDs for use on passenger automobiles and light trucks.

A/C 24-2 was developed to address two issues in particular. First, while the Clean Air Act and implementing regulations clearly prohibit defeat devices, earlier defeat device guidance on how EPA and manufacturers should implement this prohibition was somewhat general, commonly requiring case-by-case judgmental decisions by EPA. It was determined beneficial to provide objective criteria which both manufacturers and EPA could use in evaluating potential defeat devices. Second, the rapid development of sophisticated emission control systems and strategies, typically relying on advanced electronic and computer controls, provided new opportunities for optimizing emission control performance of light-duty vehicles and light-duty trucks. However, the increased sophistication and complexity also made it more difficult and time consuming for both manufacturers and EPA to evaluate AECDs for potential defeat devices. The criteria could be routinely employed by the manufacturer during the development process and prior to submitting an application for certification. It has become routine practice for the manufacturer to share with EPA the results of its own evaluation using these objective criteria. The availability of data demonstrating emission performance at or below this objective criteria significantly assisted EPA in its evaluation process and has resulted in more timely review of a manufacturer's application for certification. While this guidance provides an

objective means for manufacturers and the Agency to evaluate AECDs, as described below, such objective criteria are appropriately used as screening tools and are not binding limits.

C. Much the same situation now exists with heavy-duty engines. More sophisticated and complex emission controls are being used and the trend toward such controls continues. For the engines designed to meet the 2004 model year standards, EPA anticipates improvements in fuel metering, the use of advanced turbocharger designs and the use of cooled EGR systems, for example, to be common. These systems will be closely controlled using advanced electronics including on board computers, analogous to the trends in light duty emission controls in earlier years. Thus, as was the case for light duty vehicles and trucks, the concerns for how best to implement the defeat device prohibitions needs to reflect these technology trends. Similarly, the benefits of adopting objective screening criteria for the heavy-duty program are also apparent.

D. EPA described such a set of objective screening criteria in its October 15, 1998 guidance letter to manufacturers, "Subject: Heavy-duty Diesel Engines Controlled by Onboard Computers: Guidance on Reporting and Evaluating Auxiliary Emission Control Devices and the Defeat Device Prohibition of the Clean Air Act." We issued this guidance to ensure manufacturers clearly understand the need and regulatory obligation to identify and report AECDs for EPA evaluation against the defeat device prohibition. This guidance also established screening tools to assist EPA in evaluating the appropriateness and impact of AECDs which affect emissions performance outside of FTP operating conditions. This guidance letter included specific test procedures and emission performance assessment criteria applicable to heavy-duty on-highway diesel engines for the 2000 and later model years as well as design screening criteria applicable to the 2000 and later model years of both heavy-duty diesel highway engines and nonroad diesel engines.

The emissions performance screening tools included in the October 1998 manufacturer letter centered around the EURO III steady state test and the not-to-exceed (NTE) test (hereafter referred to as the Supplemental Emission Test and NTE test). Technical specifications and testing requirements for these tests were included in the guidance letter as well as specific emission performance screening limits. Also included were objective design-based criteria which defined when it is appropriate to activate certain commonly used AECDs (such as injection timing advance during cold engine operation to prevent misfire and limit white smoke). AECDs which do not exceed the emissions performance screening criteria when evaluated according to these test procedures and which fall acceptably within the design-based screening criteria would then, absent other information suggesting potential defeat device concern, be considered by EPA to not warrant further defeat device investigation and would be considered acceptable for certification.

This Advisory Circular 24-3 incorporates much of the information contained in the October 1998 guidance letter as it pertains to heavy-duty on-highway diesel engines, updating some of the technical information and expanding on the description of EPA's implementation policy. Nevertheless, the reader may wish to consult the October 1998 guidance letter for additional discussion on the need and procedures for identifying AECD's and for additional background.

E. Finally as background, EPA published final requirements for model year 2004 and later engines on October 6, 2000 (65 FR 59896). Applicable beginning with the 2007 model year, engines must comply with the Supplemental Emission Test and the NTE test limits as well as the FTP standards. These regulations adopted some modifications to the Supplemental Emission Test and NTE test procedures and the compliance requirements compared to those specified in the October 1998 manufacturer guidance letter.

III. Applicability

This advisory circular is applicable to heavy-duty diesel engines certified for use in on-highway applications and in compliance with the 2.4 g/bhp-hr NMHC + NO_x emission standard.

IV. Definitions

For on-highway heavy-duty diesel engines, the following regulatory provisions apply:

1. Auxiliary Emission Control Device (AECD). An AECD is any element of design that senses temperature, vehicle speed, engine RPM, transmission gear, manifold vacuum, or any other parameter for the purpose of activating, deactivating, or modulating the operation of any part of the emission control system. See 20 CFR 86.082-2 and 86.094-2.

2. Defeat Device. A Defeat Device is an AECD that reduces the effectiveness of the emission control system under conditions which may reasonably be expected to be encountered in normal vehicle operation and use, unless (1) such conditions are substantially included in the applicable Federal Emission Test Procedure for heavy-duty vehicles and heavy-duty engines described in subpart N of 40 CFR Part 86; (2) the need for the AECD is justified in terms of protecting the vehicle or engine against damage or accident; or (3) the AECD does not go beyond the requirements of engine starting.

V. Consideration of Basic Design

As discussed above, an AECD can include any element of design or control strategy including, for example, elements of the basic fuel metering and timing strategy imbedded within the engine's computer control system as well as switches, timing devices and other pieces of hardware since any of these could clearly be recognized as devices which could impact emission performance during operation outside that well represented by the FTP. In determining whether there is a need for the AECD to prevent damage to the engine, EPA will consider the whole engine and emission control system to evaluate any impact on emission performance outside of the FTP operating conditions.

This approach to defeat device evaluation by considering the entire system is appropriate due to the many interdependencies between individual components or elements of design in modern heavy-duty engines. For example, turbocharger systems can be limited by high compressor discharge temperature which in turn is influenced by a wide range of parameters including such parameters as the ambient temperature, altitude, under hood cooling design, EGR strategy and calibration, and the horsepower requirements of the engine during these non-FTP operating modes. In evaluating whether an AECD is needed to protect the engine's turbocharger system against over temperature conditions which could result in damage to the turbocharger system, EPA needs to evaluate the design strategy across the wide range of such inter-related parameters, for example, to determine if the protection is necessary, or is the result of the selection of inferior designs. As set out in the 1998 guidance, EPA will not approve an AECD for a frail engine design where the need for engine protection is the result inadequate design of the engine, when viewed in comparison to available technology.

EPA prefers to rely on emission performance rather than design specifications in determining whether a manufacturer's proposed product offering qualifies for emissions certification. Thus a variety of design strategies may be acceptable if they all provide acceptable emissions performance. Indeed, EPA encourages design innovations on the part of individual manufacturers as this can result in improved product offerings and less cost to manufacturers and consumers. However, in the case of defeat device evaluations, we must evaluate any increase in emission levels by considering the design strategy selected by the manufacturer.

In evaluating whether an AECD is a defeat device, EPA will consider the impact on emissions during operating conditions not well represented by the FTP using the objective screening criteria set forth in this A/C. If the AECD's impact on emissions performance is not within the guidelines described in section VI. 1 and VI. 2 of this A/C or the AECD is not accepted via the specific design criteria described in section VI. 3 of this A/C, then EPA will consider whether the emission control system represents a reasonable design attempt by the manufacturer to control emissions over all operating conditions. If an AECD is expected to cause an excessive increase in any regulated pollutant, EPA will consider whether design alternatives are available which would make the engine/emission control system less susceptible to the need for an AECD that increases emissions to the extent of the proposed AECD.

A. AECDs required to protect the engine/emission control system

This type of an AECD would generally modulate some part of the system during non-FTP operating conditions for the purpose of protecting the system against damage. Using the example of over temperature protection of a turbocharger, EPA will consider whether alternative engine and emission control systems including turbocharger systems are available that would further limit the concern for over temperature damage or otherwise reduce the likelihood of high temperature operation so as to also avoid damage to the turbocharger. In determining what alternative engine and emission control system designs are available, EPA will consider those designs available in other applications including those applications certified by other manufacturers which would be reasonably transferable to this particular manufacturer's design. If a manufacturer chose to certify a heavy-duty diesel engine without incorporating an element of

design typically found on other certified designs (for example, the manufacturer chooses to use an aluminum or copper EGR cooler which requires, for corrosion protection, reducing or shutting off-EGR over a broad range of conditions not represented during the FTP, rather than using stainless steel for the EGR cooler which would require more limited, if any, AECDs for protection), EPA would consider whether the improved emission control design (stainless steel EGR cooler in this example) was reasonably available for use by the manufacturer and would have resulted in less need for an AECD which reduces the effectiveness of the emission control system. If EPA determines these conditions exist, then EPA reserves the right to determine the use of the AECD represents a defeat device.

B. AECDs which are incapable of adequately controlling emissions during non-FTP operating conditions.

The AECD examples discussed above generally describe a type of AECD which actuates or adjusts an engine or emission control system parameter during non-FTP operating conditions in a manner different from how they operated during the FTP and, in doing so, results in increased emissions. It is also possible to have an AECD which, due to its inferior design, results in higher emission levels under non-FTP conditions compared to alternatively available designs. An example might be a relatively unsophisticated EGR system which performs well enough under FTP conditions to meet the FTP standards, but this same operation under speeds and loads not well represented by the FTP or at higher temperatures would result in insufficient exhaust gas re-circulation and significantly increased NO_x emissions. EPA will examine the anticipated emission performance under non-FTP operating conditions and, if the emission levels exceed those of the objective criteria described in section VI., will consider the basic design strategy of the engine and could determine the existence of an unacceptable AECD even if the strategy physically has the same limits or range of operation during both FTP and non-FTP operating conditions. The existence of a defeat device strategy may be determined especially if the manufacturer's choice of a basic design strategy is incapable of approaching the same degree of control compared to alternative systems more typical of the industry.

VI. Screening Tools to Assist in Evaluating AECDs

EPA will use three objective screening tools in evaluating compliance with the defeat device prohibition. The first two tools are emission performance screening tools called the Supplemental Emission Test Limits and Not-to-Exceed (NTE) Limits. The third tool is a set of design-based screening criteria. EPA will also use any other available information relevant to determine compliance with the defeat device prohibition.

1. The Supplemental Emission Test is a test based on the European steady-state engine certification test. The test consists of 13 steady-state modes covering a broad range of highway-type operating conditions. The Supplemental Emission Test demonstrates the emissions performance of engines over these highway-type operating conditions. The testing and technical requirements for conducting the supplemental EURO III test are described in 40 CFR

86.1360; these are the requirements adopted for mandatory testing beginning with the 2007 model year for these engines. These testing requirements update those included in the October 18, 1998 guidance letter to manufacturers described earlier; the manufacturer should follow the procedures adopted in the regulations rather than those included in the October 1998 guidance letter.

The acceptable emission performance limits which EPA will use under this A/C for this Supplemental Emission Test are described in 40 CFR xxxxx.

EPA may choose to conduct this Supplemental Emission Test over the same temperature and altitude range as the FTP standards.

2. In addition to Supplemental Emission Test results, EPA will use a Not-to-Exceed (NTE) test to screen for a wide variety of potential defeat devices. The NTE defines a broad range of engine speed and load points (called the NTE Control Area) under which engines are expected to emit at reasonable levels in normal ambient conditions. The testing and technical requirements for conducting the NTE test are described in 40 CFR 81.1370; these are the requirements adopted for mandatory testing beginning with the 2007 model year for these engines. These testing requirements update those included in the October 18, 1998 guidance letter to manufacturers described earlier; the manufacturer should follow the procedures adopted in the regulations rather than those included in the October 1998 guidance letter.

The acceptable emission performance limits which EPA will use under this A/C for this NTE test are described in 40 CFR 86.007-11(a)(4)(i).

EPA may choose to conduct this NTE test over temperatures ranging up to 100 degrees F and altitudes ranging up to 5500 feet; these are the temperature and altitude ranges required under the mandatory test program described in 40 CFR 86.007-11(a)(4)(ii).

3. Finally, EPA will use objective design-based screening criteria to evaluate specific AECDs with respect to the prohibition against defeat devices. The design criteria are the same as described in Attachment III to the 1998 guidance letter referenced earlier.

A particular engine strategy, as reported in the certification application satisfies the objective design-based screening criteria if it is within the criteria described in Attachment III to the 1998 guidance letter.

VII. EPA Evaluation of Potential Defeat Devices

A manufacturer has a responsibility to describe all AECDs in its application for certification. Thorough disclosure of the presence of such an AECD and its expected impact on emission performance is essential in allowing EPA to evaluate the AECD and determine whether it represents a defeat device. Clearly, any AECD which is not fully identified in the manufacturer's application for certification and for which emissions impacts are not provided

cannot be appropriately evaluated by EPA and therefore cannot be determined to be acceptable by EPA.

One way that a manufacturer can help assure itself that a device or control strategy does not represent a defeat device is to conduct tests under the Supplemental Emission Test and NTE tests adopted as part of the 2004 Heavy Duty Engine standards final rule (October 6, 2000; 65 FR 59896). Where manufacturers provide data on their certification test engines which demonstrate that the device or control strategy does not cause the engine to exceed the NTE and Supplemental Emission Test screening limits set forth in this A/C, EPA believes there will be no need for additional testing or evaluation by EPA unless EPA has some specific reason for questioning the accuracy of the manufacturer-supplied data (for example due to questionable implementation of the test procedures) or believes the data does not suggest acceptable performance under other operating conditions (for example, if a manufacturer supplied data on a limited portion of the NTE Control Area and not under conditions expected to result in maximum emission levels, then EPA may choose to conduct additional testing to better represent, in this example, NTE performance). EPA does not intend to conduct confirmatory testing during certification to evaluate AECDs for manufacturers who have supplied valid test data demonstrating that their AECDs do not result in exceeding the emission performance levels provided via this A/C. If all available data sufficiently demonstrate that the AECDs are not expected to result in emission levels exceeding the screening criteria, EPA sees no need for further information to evaluate whether satisfactory emission control is maintained over a wide range of typical in-use operating conditions. Absent other information raising significant concern about the potential existence of a defeat device, such as an identified AECD that appears designed to circumvent the screening criteria, EPA would intend to rely upon this emission performance data and the manufacturer's description of its AECDs in issuing a certificate of emission compliance.

A determination of acceptable performance during testing of a certification engine of course does not necessarily mean acceptable emission performance on typical production engines or during typical consumer operation. EPA expects that manufacturers will assure their production line and in-use engines also conform to the applicable standards and the prohibition against defeat devices. EPA may choose to evaluate such engines after certification approval and expects to use the same screening tools to evaluate compliance with the defeat device prohibition.

EPA intends to use its authority 40 CFR 86.004-16 and CFR 86.091 - 29 (b) to test certification engines according to procedures referenced above, when appropriate, to evaluate the emission impacts of any AECD which the Agency is concerned may result in increases in emissions during operation not well represented by the FTP. This includes testing according to the Supplemental Emission Test and NTE test procedures as well as testing at ambient temperature and altitude conditions described above. Any such testing that the Agency deems necessary in order to complete its defeat device evaluation may, according to 40 CFR 86.091-29(b)(2), be conducted at a site of EPA's choice including the manufacturer's test facility. Any such necessary testing must be completed and the results considered before EPA will proceed with any decision to certify the affected engine family(ies). Therefore manufacturers should

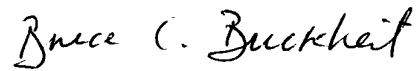
consider the potential need for such supplemental testing in planning their certification program so as to assure that any potential investigation which might include supplemental testing not delay any needed production start.

EPA will also use the objective design-based criteria as described in Attachment III to the 1998 guidance letter.

Engines tested according to these procedures and not exceeding the screening criteria performance limits referenced above, meeting the design-based objective criteria and absent any other information suggesting a defeat device concern will be determined by EPA to not warrant further defeat device investigation. Engines failing to satisfy these criteria will need to be further evaluated on a case-by-case basis and may be determined to be incorporating prohibited defeat devices. For AECDs which cause emissions to exceed these performance criteria, EPA will evaluate the need for the AECD based upon the information supplied by the manufacturer in its application for certification. EPA may conduct additional testing or may request the manufacturer supply additional information if necessary to make a defeat device determination.



Gregory A. Green, Director
Certification and Compliance Division
Office of Transportation and Air Quality



Bruce C. Buckheit, Director
Air Enforcement Division
Office of Regulatory Enforcement